Avg = 12.6 / 20

Physics 142 **QUIZ #3** **Name** Key

Thursday, July 31, 2008

1) In a certain region of space, the electric field is zero. From this fact, what can you conclude about the electric potential in this region?(2 pts)
   a) It is zero.
   b) It is constant.
   c) It is positive.
   d) It is negative.
   e) None of these answers is necessarily true

b $\vec{E} = -\vec{\nabla} V$ so $\vec{E} = 0$ implies V is constant

2) In a certain region of space, a uniform electric field points in the positive x direction. A particle with negative charge is carried from x=20 cm to x=60cm.

$\vec{E} = E_0 \hat{i}$

20cm 60cm

Does the potential energy of the charge-field system (2 pts)
   a) Increase?
   b) Decrease?
   c) Remain the same?
   d) Change unpredictably?

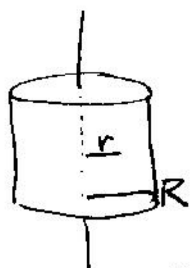
It takes work to move NEG charge to the right, so P.E. must INCREASE

Does the particle move to a position where the electric potential is (2pts)
   e) Higher than before?
   f) Unchanged?
   g) Lower than before?
   h) Unpredictable?

Electric field is uniform so pot'l is constantly changing

$V = -E_0 x$ therefore $-dV/dx = E_0 \hat{i}$

3) A long cylinder of radius R has a uniform charge density ρ. Find the electric field at a distance *r* away from the axis, where *r* < R. (8 pts)



Gaussian surface = cylinder of radius r, height h, surface area $2\pi r h$ $(+2\pi r^2)$ = A

Field points radially outward

Gauss' Law $\oint \vec{E} \cdot d\vec{A} = 2\pi r h E = \frac{Q}{\varepsilon_0} = \frac{\pi r^2 h \rho}{\varepsilon_0}$

$$\vec{E} = \frac{\rho r}{2\varepsilon_0}\hat{r} \leftarrow \text{radially outwards}$$

Integrate the field to find the potential difference ΔV between *r* and R if we move radially outward. Remember the E-field is the *negative* of dV/dr. (4 pts)

$$\Delta V_{r\to R} = -\int_r^R E\,dr = \frac{-\rho}{2\varepsilon_0}\left(\frac{R^2-r^2}{2}\right) = \frac{\rho(r^2-R^2)}{4\varepsilon_0}$$

What is the potential difference ΔV if we move from *r* to R radially, then rotate tangentially around the perimeter of the cylinder Φ degrees? (2 pts)

Tangentially the Voltage stays the same. The $\vec{E}$ field points radially outward, so $\vec{E}\cdot d\vec{\phi} = 0$